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Metrication and the Consumer

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Today, the United States is virtually an island in a worldwide sea of metrication. Since 1790, when the French Academy of Sciences created the metric or decimal measurement system, all but five countries have adopted (or been committed to change to) the metric system. The other nonmetric countries–Brunei, Burma, Liberia, and Yemen–are all small and nonindustrialized.

The day is approaching when Americans will no longer live on this island. Conversion to the metric system of weights and measures may soon have an impact on our daily lives. Eventually Americans will have to think only in metric units when shopping, building homes, traveling, sewing, cooking, preparing meals, dieting, and so forth. The question is no longer "Will we?," but "When?"

PROGRESS TOWARD METRICATION IN THE UNITED STATES

In 1790, Thomas Jefferson first advocated the adoption of a system of weights and measures based on decimal ratios. During the last two centuries, Congress has considered the merits of the metric system many times. In 1866, Congress legalized the use of metric units in commerce and by any person who wanted to use them. Since 1893, internationally agreed-to metric standards have served as the fundamental U.S. standards for weights and measures. That is, the customary units such as yard and pound are defined in standard metric units.

Metric units are currently being used for such things as camera lenses, film sizes, prescription drugs, cigarettes, and Olympic and international sports events. Although canned food labels contained no supplementary metric information in 1960, volume or weight information in metric units was included on about one-half of the labels by 1970.

In 1968, Congress authorized the National Bureau of Standards of the U.S. Department of Commerce to study all aspects of conversion to metric units. In 1971, the Bureau recommended the change to metric. The 93d Congress enacted legislation providing for a program to encourage educational agencies and institutions to prepare students in the use of the metric system. This was the first major activity needed to prepare for a metric nation. Many teachers throughout the United States have begun to teach students to "think metrically."

The 94th Congress is again considering metrication. The proposed legislation is for a voluntary change to a predominant but not exclusive use of the metric system. The purpose for legislation by Congress is to establish a national policy and create a mechanism for planning and coordinating an orderly change to the International Metric System on a national scale. Additional legislation (both Federal and State) will be required to permit interstate and intrastate trade of many products in only metric units, because some present laws specify the sale of products in customary units only (such as butter in ¼-, ½-, or 1-pound increments).

Industry has not waited for Congress to act. Many companies are already producing parts and equipment

scaled in metric units. Various consumer, labor, professional, technical, and trade organizations have united to develop uniform standards in metric units for engineering, manufacturing, and marketing operations by means of voluntary consensus.

In industry's change to metric, four basic principles are being followed:

1. **Rule of reason.** A change to metric will be made only where it is advantageous to do so. Not everything has to be put into a completely new system.

2. **No governmental subsidies.** Costs for conversion lie where they fall. Machines are being converted when they need to be replaced.

3. **Voluntary changeover.** Private industry is leading the change to metric. Many groups within an industry are cooperating to provide modular coordinated metric products. For instance, lumber, wood products, building, and construction industries and architects are recommending a 100-mm module and 300-, 400-, and 1200-mm spacings in the design of wood structures.

4. **Nongovernmental initiative.** Federal agencies, such as the National Bureau of Standards, are providing metric information but are not making its use mandatory.

WHY GO METRIC?

"Going Metric" means more than a soft conversion, which involves only a conversion to metric language of measure. It means hard conversion or a change from the standards based on the customary inch, pound, or quart module to standards based on the meter, kilogram, or liter module. A soft conversion offers no tangible benefits either in production efficiency or international markets, whereas a hard conversion does.

The primary reason for going metric is to increase our exports of manufactured products and thus help our balance of trade with other nations. Foreign customers of products made in customary units are becoming scarce. It is becoming increasingly difficult and costly to fit a 4-inch peg into a 10-centimeter hole.

Simplification of length, weight, and volume determinations would reduce the many man-hours required to calculate in base-12 and base-16 units. The unrelated units in the customary system complicate each linear measurement. Units of length are not related consistently—12 inches = 1 foot; 3 feet = 1 yard; 5½ yards = 1 rod; 320 rods = 1 mile. Volume measures are equally inconsistent—3 teaspoons = 1 tablespoon; 16 tablespoons = 1 cup; 4 cups = 1 quart. Metric units are interrelated and are in multiples of 10; thus the system is easy and fast to use.

Many opportunities for improvements in describing and marketing merchandise or information are raised with the change to the metric: Establishment of equipment standards and interchangeable machine parts, reduction in numbers of product or container sizes, simplification of container sizes, simplification in price comparisons of products, and more descriptive terminology for products.

SI

Since its inception, the metric system has undergone many changes. In 1790, the meter was established as a measured portion of the earth's circumference. Measures of capacity and mass were derived from the length unit. The modern metric system "Le Système International d'Unités" (SI) resulted from an international General Conference on Weights and Measures in 1960 at which the United States was a participant. The meter was redefined in terms of wavelengths and a comprehensive specification for units of measurement, including base, derived, and supplementary units, and prefixes, was established. As the need arises, changes are made in SI at General Conferences held periodically.

The conversion to metric in the United States will be to SI units. Today, there are just seven SI base units which by convention are considered as dimensionally independent—length (meter), mass (kilogram), time (second), electric current (ampere), thermodynamic temperature (kelvin), amount of substance (mole), and luminous intensity (candela). Other SI units are derived from the base units by combining base units according to algebraic relations linking the corresponding quantities such as kilometers per hour for speed and cubic meters for volume. Because the General Conference in 1960 declined to designate two units—plane angle (radian) and solid angle (steradian)—as either base or derived units, they are called supplementary units.

Fortunately, most consumers will be concerned with just a few measurements—those for length, capacity or volume, mass or weight, temperature, and perhaps energy. They

need to learn about meters, liters, kilograms, degrees Celsius, and perhaps joules, plus three prefixes–milli-, centi-, and kilo- (see table).

Multiples and fractions of a unit are expressed by decimals. Conversion of a unit to another size involves just moving the decimal point–232 000 millimeters = 23 200 centimeters = 232 meters = 0.232 kilometers.

The prefixes deci-(0.1), deka-(10), and hecto-(100) are seldom used. Prefixes smaller than milli- and larger than kilo- will not be used by most consumers although their use may be common in science and some specific industries or businesses, such as those in electrical, chemical, and pharmaceutical fields.

Length

The METER (metre) replaces inches, feet, yards, and miles. A meter is a little longer than a yard (1.1 yards) or approximately the distance from the left shoulder to the tip of the right hand. An aspirin tablet is 1 centimeter in diameter. About 1.6 kilometers equal 1 mile. Signs on many U.S. highways are now citing distances in both kilometers and miles.

Seamstresses may be aware that some pattern companies are already using metric measures. Some patterns show centimeter as well as inch markings for body measurements, fabric requirements, seam allowances, and cutting layouts.

Changes to the metric measuring system raises opportunities for improvements. The present sizing system for clothing, particularly children's and women's clothing, grew without any reason. With the metric system comes the opportunity to wipe the slate clean and make a fresh start–that is, to develop more specific designations which reflect body measurements.

Solutions to some measurement problems will be much simpler in meters than in customary units–problems such as those encountered in remodeling, or redecorating rooms and homes. How much fabric is required to curtain windows, slip-cover chairs, and make a dress? Will a chest go through the door? Will a built-in appliance fit in the designated space? What size bread, cake, or pie pan will be needed for a recipe? These problems will be simpler to compute in meters because there will be no need to convert inches to feet to yards or to work with fractional parts.

Volume

The CUBIC METER is the SI derived unit for volume. The LITER (litre), although not a SI derived unit, is commonly used to measure the volume of foods and liquids and replaces teaspoons, tablespoons, cups, pints, quarts, and gallons. The liter is derived from cubing the decimeter (0.1 of a meter). Thus, 1 cubic decimeter (dm^3) = 1 liter, or you may remember from chemistry class, 1 cubic centimeter (cm^3) = 1 milliliter (ml). The liter is a little more than 1 quart and 4 liters is about 1 gallon.

Initially during the transition period, containers may state contents in both customary and metric units, such as 1 quart or 0.95 liter (a soft conversion). By the end of the transition period, containers will be labelled only with the rounded metric unit, such as 1 liter (which is about 1.06 quarts). Changes in the container dimensions (probably height) will be made to accommodate the greater amount.

Bottlers will simplify their operations by reducing the number of bottle sizes. The domestic wine beverage bottlers

Units and symbols consumers will commonly use

Measurement	Multiples of base unit			
	0.001 or 1/1000	0.01 or 1/100	1 or BASE	1000
Length	millimeter (mm)	centimeter (cm)	meter (m)	kilometer (km)
Weight (mass)	milligram (mg)	- - -	gram (g)	kilogram (kg)
Volume	milliliter (ml)	- - -	liter (l)	- - -
Temperature	- - -	- - -	°Celsius (°C)	- - -
Energy	- - -	- - -	joule (J)	kilojoule (kJ)

plan to reduce the number of bottle sizes from 16 to 7 by January 1, 1979—the first major U.S. industry to convert to metrication.

Mass

Weight is a measure of the force of a pull—gravitational pull—but here on earth, the weight of an object is very nearly the same as the mass, so the mass of an object is estimated by weighing it.

The KILOGRAM is the SI base unit for mass and replaces ounces and pounds. It is the only base unit whose name, for historical reasons, contains a prefix. 1 kilogram equals 1000 grams, which is about 2.2 pounds. A paper clip weighs about 1 gram, a nickel about 5 grams.

No one can tell exactly what something weighs just by looking at it. Volumes of 100-gram samples of dry milk, flour, sugar, and salt are quite different: Dry milk—315 ml, flour—200 ml, sugar—120 ml, and salt—80 ml. Incidentally, 1 kilogram of water = 1 liter of water = 1 cubic decimeter of water at 20 °C.

Dual weights and measures now appear on many food labels. Some canned food labels give contents in pounds and ounces and in grams, such as 8 ounces or 227 grams (a soft conversion). Eventually, cans labelled with the exact conversions of customary units will be replaced by larger cans labelled only with rounded metric units, such as 250 or 500 grams.

Temperature

The SI base unit for temperature is KELVIN. On the kelvin scale, water freezes at 273.15 K and boils at 373.15 K. In common practice, "degree Celsius" is used instead of "kelvin"; the intervals of differences in temperature on the two scales are the same. On the Celsius temperature scale, water freezes at 0°C and boils at 100°C, which is the same as the centigrade scale you may have learned about in science classes. Each degree Celsius is equivalent to about 1.8°F.

Temperature relationships in degree Celsius can only be learned with experience just as we learned those in degree Fahrenheit. 0 °C is freezing point of water; 20 °C is room temperature; 37 °C is normal body temperature; 60 °C is internal temperature to which meat is cooked to rare doneness; 100 °C is boiling point of water at sea level. When the weather forecaster says the temperature will be 37 °C, Americans will soon learn that it will mean bikini rather than topcoat weather. Temperatures in weather forecasts in some U.S. locations are being given in both degrees Celsius and degrees Fahrenheit. Control dials on new ovens will probably be dual-labelled with both Celsius and Fahrenheit scales, and eventually be marked only in degree Celsius.

Energy

The JOULE is the SI derived unit for energy measurements (including quantity of heat). The joule is defined as work done in moving 1 kilogram of mass through 1 meter of space in 1 second of time. The calorie, which the joule will replace, is a measure of heat (thermal energy) and cannot be derived from SI base units without using an experimentally determined factor.

Like the calorie, the joule is too small for practical use; thus, the kilojoule will be used. A kilocalorie, the unit commonly used to indicate the energy value of food, is about 4.18 kilojoules.

The next revision of Composition of Foods—Raw, Processed, and Prepared (USDA Agriculture Handbook No. 8) will contain energy measurements in both kilocalories and kilojoules.

METRIC USAGE IN FOOD PREPARATION

Consumers will feel the effect of the metric system most in food prepration because several sets of measurements are involved daily—measures for volume, weight, and temperature. However, metrication in food preparation will not mean throwing out favorite recipes, cookbooks, or utensils. Today's measuring equipment can still be used with today's favorite recipes even after the Nation has gone metric.

In a few years, cookbook recipes will contain metric units. Development of some metric volume measuring device standards are required to prepare food from metric recipes. The new metric measurers will be based on the liter rather than the quart. Measurers will be available in 1, 2, 5, 15, 125, 250, 500, and 1000 ml units. Two or three measurers between 15 and 125 ml will be available but their units have not been established by an American National Standards Institute subcommittee (the group responsible for standardizing the customary measurers such as a cup or a tablespoon). The larger measurers will be marked in 25, 50, or 100 subdivisions. Some manufacturers have already introduced volume measurers marked in both customary and metric units. Unfortunately, some markings are not accurate.

Whether the mass (weight) method rather than the volume method of measuring ingredients in metric units should be suggested for use by the American consumer has been discussed considerably. The mass method is common in many large quantity food service centers and in homes in some European countries. It is more accurate, easier, and faster to use for some ingredients. However, mass measurements require purchase of scales and learning new techniques as well as learning the new units by most Americans. Because the volume method is already used by most Americans and less retraining would be involved, transition to metrics would probably be more acceptable to American consumers if just the units and not also a new procedure were introduced. Therefore, home economists will be emphasizing volume measurements in food preparation. In quantity food service, mass method of measuring ingredients will be retained with the need to purchase new scales or dials for the scales and to learn the new metric units.

Some homemakers already use metric units (volume and mass) to prepare meals. Popularity of foreign cookery has resulted in introduction of foreign metric measurers, scales, and cookbooks to some American kitchens.

Most present pots and pans can be used with metric recipes. Care must be exercised that yield of the recipe does not exceed the capacity of the pan, however.

Although conversion tables are available, appropriate measuring equipment should be used whenever possible. People should be encouraged to think metrically.

IMPLICATIONS

Over the next few years, educators, nutritionists, and others have the task of making the transition to metrics as easy as possible for the American consumer. The biggest problem in going metric is not learning the metric system but acceptance of the changeover. Changing the system of weights and measures is like giving up a comfortable pair of shoes.

New concepts need to be acquired and some that are well worn and comfortable discarded. Therefore, young children will find the metric system easier to learn than adults; young children have no concepts about measurement to discard. Some students are now learning to measure only in metric units.

A positive educational program is needed for all segments of the society. The task is made much simpler if a few principles are followed by everyone involved in the educational program.

- Accurate SI source material should be used as references. Some sources are listed at the end of this article.

- All published materials used in teaching metrics should first be checked and corrected to SI units.

- In teaching, only the SI units that are needed and will be used should be presented. It is not necessary to learn the entire SI system at one time and thus be overwhelmed. Most consumers will only need to be familiar with the units discussed in this article.

- A policy to round off units should be adopted. Although it is easy (with a calculator) to do a soft conversion, wherein the customary unit is converted to the metric unit by applying a factor, the magnitude of the result may scare new students (such as 453.5924 grams for 1 pound or 0.9144 meters for a yard). Three significant digits are usually all that are necessary.

- Rather than convert measurements from customary to metric units, it is better to develop new materials, such as recipes, based on whole metric units, such as 500 grams, 250 milliliters, or 1 meter.

- The decimal feature of the metric system should be applied in all cases. 0.5 liter or 500 ml should be used not ½ liter.

- Measurements should be kept uncluttered and few in number. Because 128 ml requires three measurements (125 ml + 1 ml + 2 ml) and 125 ml just one, the latter should be given as an ingredient amount. The ease in using metric units for measuring should be stressed. Therefore, a soft conversion of ingredient amounts in recipes to metric measures is not recommended.

- Customary names of cup, tablespoon, and teaspoon should not be used with metric units to avoid confusion.

Amounts of most nutrients have traditionally been given in metric units. With serving size also in metric units, relationships of nutrients in the food and the serving size should be more apparent.

The Metric Committee of American Home Economics Association is preparing a guide on metric usage in home economics in which SI units commonly used in all phases of home economics will be covered. The committee is also compiling a list of available educational materials. Both items will be available from the Association.

Metric information may be obtained from:

U.S. Department of Commerce
National Bureau of Standards
Washington, DC 20234

American National Metric Council
1625 Massachusetts Avenue, N.W.
Washington, DC 20036

American National Standards Institute
1430 Broadway
New York, NY 10018

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

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